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ideal factors (11th line from bottom); but this decomposition holds for the case where $\Psi_r(\alpha)$ contains only ideals of the first degree. Kummer has himself given (*Crelle*, **44**, p. 120) the decomposition for the generalized function $\Psi_r(\alpha)$ which may contain ideals of other degrees than the first and said decomposition is of a more general form than that which applies for ideals of the first degree. It would follow from these facts that in theorem IV, $F(\alpha)$ would necessarily contain factors of the first degree only. However, on page 67 of the 1857 memoir the theorem is applied to certain ideals $\Theta_r(\alpha)$ which are not proved to be of the first degree.

Also, on page 54 it is stated without proof or reference that if m is not divisible by λ-1 then

$$\frac{d_o^{m\lambda^r} l\phi(e^v)}{dv^{m\lambda^r}} \equiv \frac{d_o^{m\lambda^r} l\phi_1(e^v)}{dv^{m\lambda^r}} \pmod{\lambda^{r+1}}$$

where $\phi(\alpha)$ and $\phi_1(\alpha)$ are integers in $\Omega(\alpha)$ such that $\phi(\alpha) \equiv \phi_1(\alpha) \pmod{\lambda^{r+1}}$. The writer has not been able to find a proof of this any where in Kummer's papers.

AN IMPROVED FORM OF HIGH TENSION D. C. APPARATUS

By David L. Webster

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Communicated by E. B. Wilson, March 6, 1920

In a recent paper on X-rays in these PROCEEDINGS,[1] I described a high tension D. C. outfit based on that of A. W. Hull, with certain changes of details. On further investigation it has appeared that one of these changes introduces a disturbing factor, which was not large enough to affect the results in that paper, or to be detected by the tests for fluctuation used at that time, but which might have been detectable if the choke coils in the apparatus had not had extremely high inductances. As I have received several inquiries lately about the best way to build such an outfit and the question is of importance to X-ray research workers, I am writing this note to call attention to the existence of this disturbing factor and the way to eliminate it in outfits with inductances and capacities not so large as those used here.

In the arrangement described in the previous paper the principal A. C. components on the D. C. line had a frequency of 1000 cycles per second, twice that of the primary current, and the currents in both sides of the line increased and decreased in the same phase. The disturbing factor was the capacity of the transformer secondary, relative to the ground, that introduced components of current at 500 cycles, with opposite phases on the two sides of the line. Because of this phase relation, the 500 cycle components are difficult to choke off unless the middle points of the D. C. condenser lines are grounded, in which case the phase relation of each type of current components is unchanged, but the 500 cycle voltage fluctuations on the first D. C. condenser are increased, and its 1000 cycle voltage fluctuations are reduced. To make this change we must remove the ground connection that was on the point A, figure 1, and ground the middle points of all the D. C. condensers as indicated by the grounds, G, and incidentally, we may as well ground the cores of the choke coils also. Since the 500 cycle components have a phase relation opposite to that of the 1000 cycle ones it is well also to reverse the connections on the choke coils on one side of the line. This gives us the arrangement shown in figure 1.

To compute the potential fluctuations, let $I \sin \omega t$ be the current in the lead to either end of C_1, where $\omega = 2\pi \times 500 \text{ sec.}^{-1}$, and we neglect harmonics. This gives potentials as indicated in the diagram, where $(V + V_1)$ is the peak voltage of the transformer,

$$V_1 = \frac{I}{2C_1\omega}, \quad V_2 = \frac{V_1}{C_2L_1\omega^2} = \frac{I}{2C_1C_2L_1\omega^3}$$

and

$$V_3 = \frac{V_2(1 - C_2M\omega^2)}{C_3L_2\omega^2} = \frac{I(1 - C_2M\omega^2)}{2C_1C_2L_1L_2\omega^5}.$$

Here C_1, C_2 and C_3 are the capacities of the whole series condenser lines, and $L_1 = 2L'_1 + 2M_1$ $L_2 = 2L'_2 + 2M_2$, and M is the mutual inductance between L_1 and L_2. Because of the ω^5 in the denominator of V_3 it is evident that harmonics need not be considered, although for the 1000 cycle harmonic we must replace L_1 and L_2 by $2L'_1 - 2M_1$ and $2L'_2 - 2M_2$, respectively. To find I for a given value of the direct current I' is not easy, and the ratio of the two is not constant. But if the rise of voltage on either half of the first condenser occurred instantaneously it would not be greater than $(2\pi/\omega)I' \div 2C_1$; and, if it took a whole half cycle it would not be less than half this amount. In practice, with heavy loads the rise appears to take a large fraction of a half cycle. The slower the rise is, the less of it we may ascribe to harmonics, and thus for an approximate value of I we may assume the rise to be $2V_1$, and also to be somewhat greater than $\pi I'/2C_1\omega$. Thus I should be about $2I'$ under such conditions, and measurements confirm this relation.

This arrangement has the disadvantage of depending on a 500 cycle charging current in C_1 instead of 1000. On the other hand, if the two sides of the line are symmetrical, there should be no 500 cycle fluctuation in the total potential difference between the ends of the line. In fact with the previous type of connection we might expect that if the ground wire was removed we should have likewise no 500 cycle fluctuation in the potential difference between the ends of the line, although both ends would fluctuate relative to the ground. But this conclusion is based on the assumption of perfect symmetry between the two ends of the line, which is liable not to occur. And although the 500 cycle fluctuation on the first

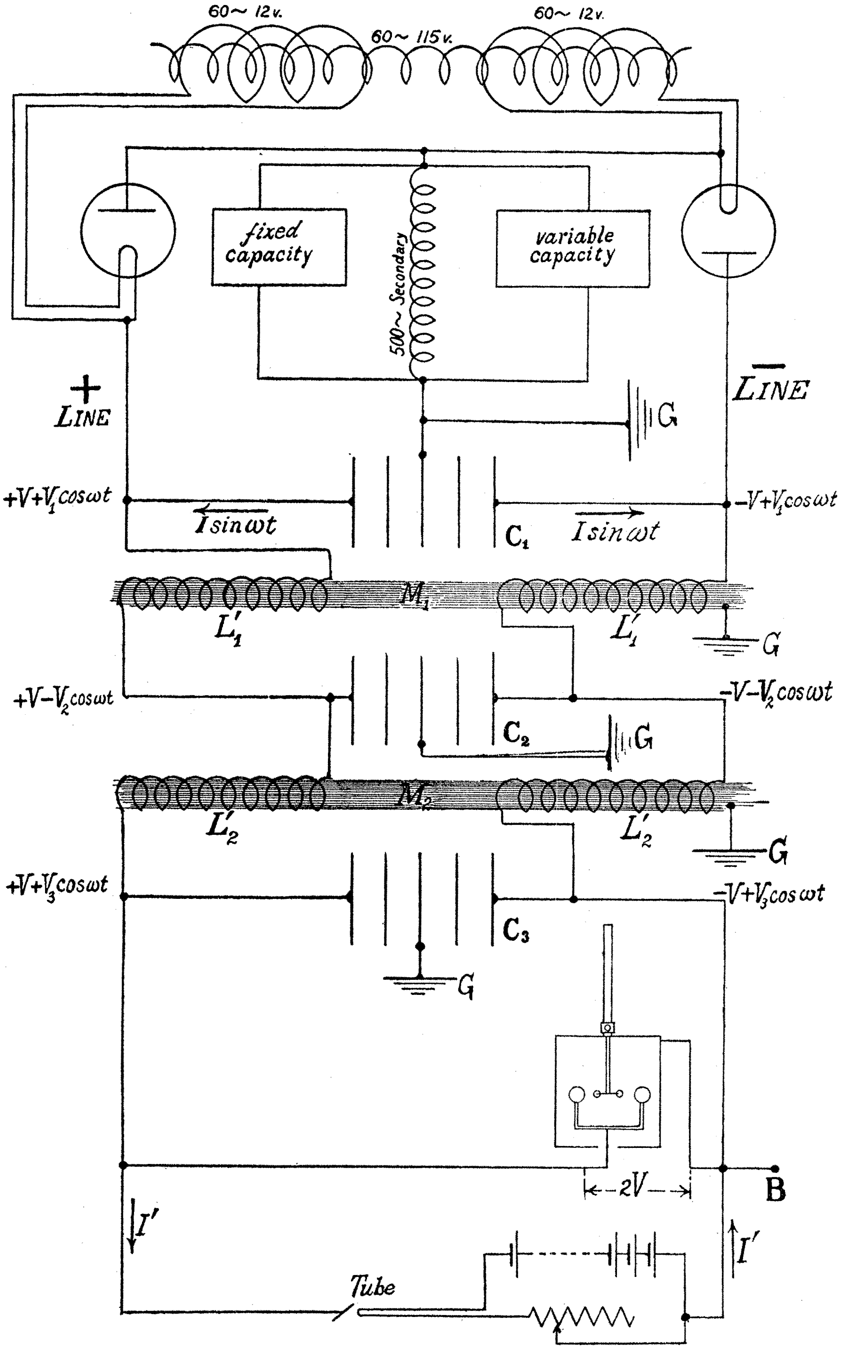
60~ 12 v.
60~ 115 v.
60~ 12 v.
fixed capacity
500~ Secondary
variable capacity
+ LINE
$\overline{}$ LINE
G
$+V+V_1\cos\omega t$
$\overleftarrow{I\sin\omega t}$
C_1
$\overrightarrow{I\sin\omega t}$
$-V+V_1\cos\omega t$
M_1
L_1'
L_1'
G
$+V-V_2\cos\omega t$
$-V-V_2\cos\omega t$
C_2
G
M_2
L_2'
L_2'
G
$+V+V_3\cos\omega t$
$-V+V_3\cos\omega t$
C_3
G
$2V$
B
I'
I'
Tube

FIG. 1

condenser is greater in the present arrangement than it would be in the other with no ground wire, that on the last condenser is much less. Hence the present arrangement is the better of the two. The advantage of having the voltage on C_1 almost twice the peak voltage of the transformer is preserved here, because we preserve the feature that is essential for this result, namely, that one end of the transformer is connected to the middle point of the first D. C. condenser line. The resonance condensers, described in the previous article, for eliminating errors due to small changes of the generator speed, can be used as they were there. In cases where the steadiest voltage is not needed and the voltage is not too high, we may cut off the filament current from one kenotron and run the tube between the other side of the line and the ground. This is useful if we need to ground one end of the tube.

For experimental tests of this apparatus I have inserted a current-type voltmeter in each of the ground lines from the middle points of the condensers, and also have used telephones in these lines. The voltmeters not sensitive enough to show the current except in C_1, and the telephones are not good for quantitative work expecially in the presence of stray 500 cycle noises, but the currents and, therefore, the voltage fluctuations are apparently of the right order of magnitude. A point illustrated by these telephone experiments is that if the voltage is raised until brush discharges occur on the line, they produce irregular fluctuations of voltage that can be clearly heard in the telephone. Anyone building an outfit of this type should take all precautions needed to avoid brush discharges and should listen for them with a telephone before relying on the steadiness of the potential.

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[1] Webster, D. L., these PROCEEDINGS, 6, 1920, 26–35.

THE EFFECT OF THE CONCENTRATION OF NITRATES ON THE REDUCING POWERS OF BACTERIA[1]

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Communicated by W. M. Wheeler, April 12, 1920

During the course of some investigations on bacteria pathogenic to insects, I frequently used the nitrate-nitrite reduction test as one of a large number of differential characters. Sometimes the tests for nitrites were positive; at other times negative with the same species of microörganism. This led me to believe that the concentration of the salt in the medium was important; in other words, that very definite amounts of salt were necessary in order that the physiological activity of reduction might manifest itself.

As shown in the accompanying table a number of species of micro-